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Monitoring and Failures of Footbridges Made from Glued Laminated Wood

Veronika Vašková[a], Roman Fojtík[b], David Pustka[b]*

[a]*Technical University of Ostrava, Faculty of Civil Engineering, Ludvíka Podéště 1875/17, Ostrava-Poruba 70833, Czech Republic*
[b]*Technical University of Ostrava, Faculty of Civil Engineering, Department of Structures, Ludvíka Podéště 1875/17, Ostrava-Poruba 70833, Czech Republic*

Abstract

To overcome natural and artificial barriers that prevent the safe movement of pedestrians and cyclists, serving footbridges. The most recent trend is to build footbridges of glued laminated wood. Wood itself is an organic material. Therefore, it is important to protect it and thus ensure the longevity of objects produced from it. It is important to correct sizing of the structure and its subsequent maintenance. Revealing critical places and factors may lead to the correct choice of design, construction details and clearly given a maintenance plan, which does not currently exist, thus ensuring longevity of emerging and existing footbridges.

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Keywords: Wooden footbridge; glued laminated wood; static test; dynamic test; disorders

1. Introduction

In the course of a few recent years quite a lot of wood footbridges were constructed in the Czech Republic (see e.g. [1,2]). Development of new ways improving performance properties of wood and wood structures significantly contributed to the realization of these constructions. Important advances in this development represent e.g. technology of production of glued laminated wood and new types of connections for wood and steel (see e.g. [3,4,5,6,7,8]). Footbridges made of wood are significantly cheaper than footbridges from other structural materials. This was undoubtedly one of the key factors, which led to the selection of this material for previously mentioned

* Corresponding author. Tel.: +0-420-597-321-949.
E-mail address: david.pustka@vsb.cz

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realized footbridges. In the case of wood footbridges it is very important to ensure their appropriate durability. All issues related to the protection and maintenance of wood structures should be considered already during design process. One of ways how to protect wood is to keep it dry.

2. Types of structures for monitoring

Monitored types of footbridges are constructed from wood. Structural system consists of two main glued laminated wood beams. These beams are simply supported. To fulfill limits for deflections of structure (serviceability limit state) haunched beams can be used. Support of bridge deck is realized using cross beams and longitudinal girders (all these from glued laminated wood). Connections of cross beams and longitudinal girders are in the form of welded steel plates and steel bolts. Crossbeams are thus simply supported. Longitudinal girders represent continuous beams with 3 - 6 bays. Spatial bracing is ensured by steel tie members, which are situated below bridge deck between cross beams.

3. Goals and ways of measurement

Main reasons for monitoring of these structures are to obtain necessary data for determination of structural durability. At the beginning of service life it is performed first monitoring. It comprises measurement of basic properties of used material (e.g. humidity), static test and dynamic test. All the data are used in the future for the comparison with the results of next monitoring. In case of footbridges there are performed two types of measurements, which allow determine initial parameters. These measurements are represented by a static test and a dynamic test. Preparation, execution and evaluation of these tests are driven by the code [9]. The code [10] contains instructions how to test structures for carrying capacity, but these measurements for footbridges are not usually used. These tests allow determine maximum deflections, indentations in supports, self-excited frequency, damping and other dynamic characteristics.

3.1. Static test

For static tests carried out on bridges there are usually used automobiles. But for footbridges this type of load cannot be frequently applied. Good alternative is a barrel filled up with water from close watersource. This load is usually applied in the middle of the footbridge.

3.2. Dynamic test

For dynamic tests there are usually used loads, which are assumed to be possible in real situations for evaluated structure. For this purpose there are used either a person or group of persons. A person (or group of persons) performs these load states: walk in the frequency about 1 Hz; walk in the frequency about 2 Hz, jog and sprint. All these load states are performed for both directions of monitored footbridge. The last load state is performed by an impact in the critical part of a footbridge (e.g. in the midspan). This impact is applied by a group of persons.

4. Footbridges from glued laminated wood (GLW)

Among monitored structures belong all available types of structural systems (beam structures, arch structures, suspended structures, etc.). This paper focuses on the research of footbridges made of glued laminated wood.

4.1. Glued laminated wood

Production of GLW is based on gluing of individual wooden lamellas using suitable glue. Orientation of longitudinal fibers of lamellas is identical with longitudinal direction of a final product. Lengths of lamellas are usually between 1.5 to 5 meters. The thicknesses of lamellas are dependent on the shapes of final beams. For curved